Fig 1: Impingement style ~~Heat~~ Transfer

NATURE AND USEFULNESS OF IMPINGING JETS

One method for producing relatively large forced-convection heat transfer coefficients on a surface by air (or other gas) is the use of a multiplicity of jets impinging on the surface ("IJ" in Fig. 1).

As the air jet approaches close to the surface it turns by an angle of 90°, and thereby becomes what is called a "wall jet" (after this 90° turn), identified as "WJ" in Fig. 1.

As the wall-jets from two adjacent impinging-jets approach each other their interference forces the flow to separate from the surface and form a stream -- often of relatively low velocity -- flowing past the impinging jets to reach the exit where the gas is removed. This flow may be called the "spent flow," and is identified as "SF" in Fig. 1. This spent flow tends, however, to deflect the impinging jets somewhat from their initial direction, and can thereby reduce the average convective heat transfer coefficient, and make it nonuniform from the region around one jet compared to the region around another jet nearer the exit.

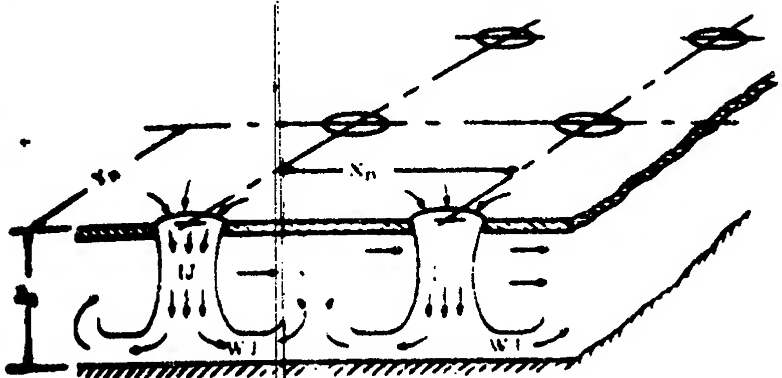


Fig. 1 Array of round jets in thin plate.

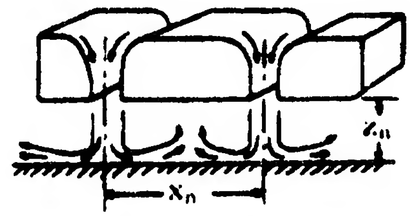


Fig. 2 Array of parallel slot jets with nozzle-shape slots.

CROSS-SECTION SHAPES OF IMPINGING JETS

Two alternative types of impinging jets are each in common use in industry, namely, arrays of "round jets" -- as illustrated in Fig. 1 -- and slot jets, as in Fig. 2. Either type can use either a square-edged orifice, as in Fig. 1, or a nozzle-shaped inlet, as illustrated in Fig. 2.

For a single row of impinging round jets, the average heat transfer coefficient, h_{av}, is not much different from that for a single slot jet, provided the total cross-section area of the jets and the arrival velocity, are the same for both types of jets, and provided further that the range of conditions is that specified immediately after Eq. (3.6-3) below. But for the same average velocity in the slot as in the round orifices, the arrival velocities can differ considerably, with consequences explained later. For much of the range of configurations of practical interest (as specified later) rows of round jets yield higher average heat transfer coefficient, h_{av}, than slot jets with the same velocity at the orifice or slot and the same shape of inlet edge of the orifice or slot.

Multiple rows of round jets, furthermore, generally yield significantly lower h_{av} than a single row (Refs. 3.6-1, -3 and -6[*]). Multiple rows are often resorted to when a single row does not suffice to produce enough total heat transfer.

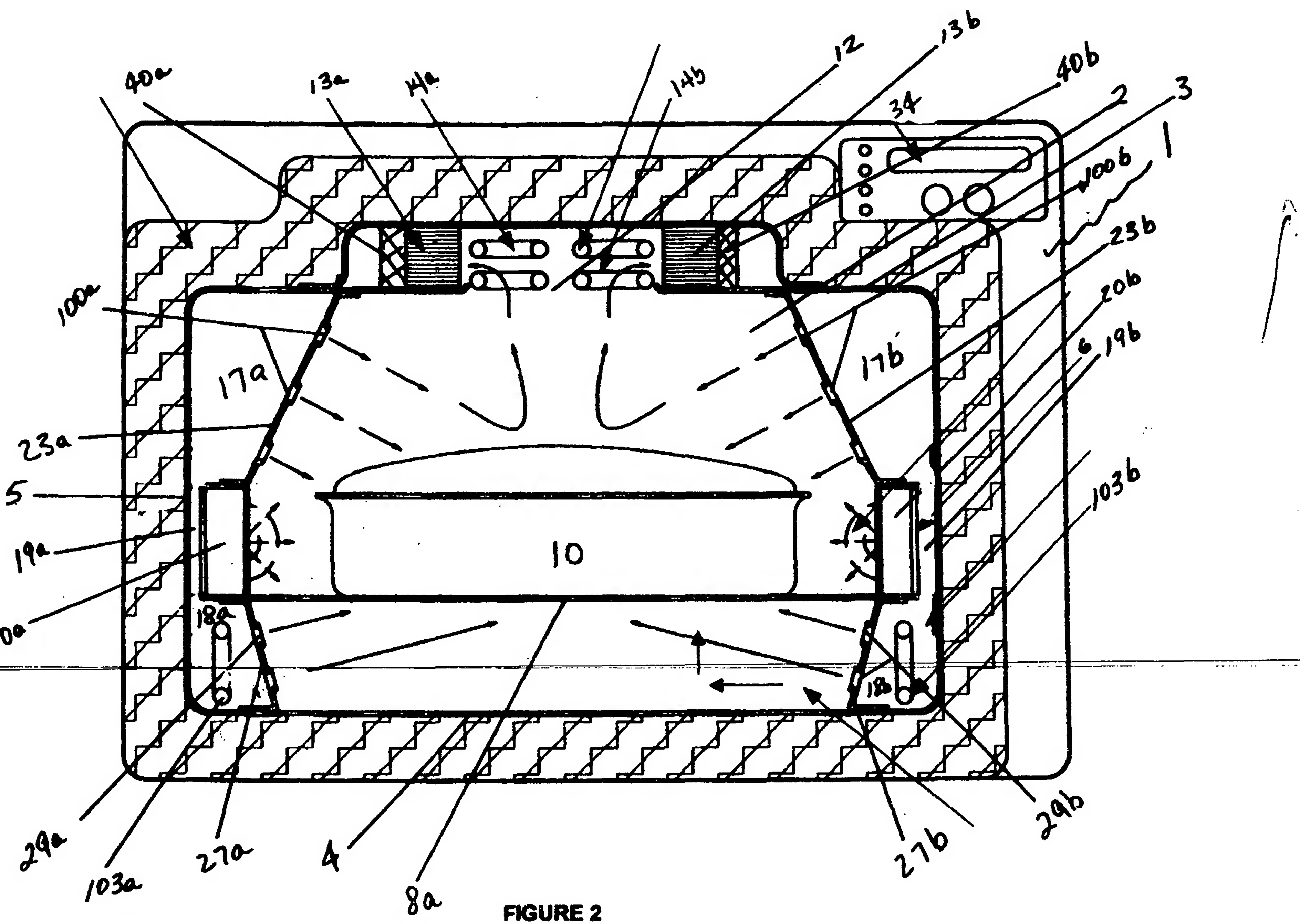
Practical applications of impinging jets -- of one type or the other -- include cooling or heating of moving sheet metal (as applied by the Industrial Heating Department), and drying of moving paper or textiles.

SHAPE OF THE SIDES OR EDGES OF THE JET ORIFICE

The heat transfer coefficient for an impinging jet depends not only on the gas velocity, the diameter, D_o, of the orifice (if round) or the slot width b (if a slot), and the spacing dimensions (X_n, Y_n, and Z_n in Fig. 1) but also on the shape of the sides of the orifice which provides each jet.

If this orifice is a square-edged hole in a relatively thin sheet, the flow will of course converge into a "vena contracta" a short distance downstream of the orifice. If, however, the jet is provided by flow from a round tube at least three diameters long, or from a bell-mouthed nozzle, there will be no such convergence. Unfortunately, attempts to obtain a simple relation between the dimensionless heat transfer correlation for jets without vena contracta and the one for jets with vena contracta have been unsuccessful (Ref. 3.6-1).

[*] References identified by numbers containing the prefix 3.6 are listed in Section G503.6, page 3.



40a
13a
14a
14b
12
13b
40b
34
2
3
100b
1
23b
20b
6
19b
103b
100a
17a
17b
23a
5
19a
20a
10
18a
18b
29a
103a
27a
4
8a
27b
29b

FIGURE 2

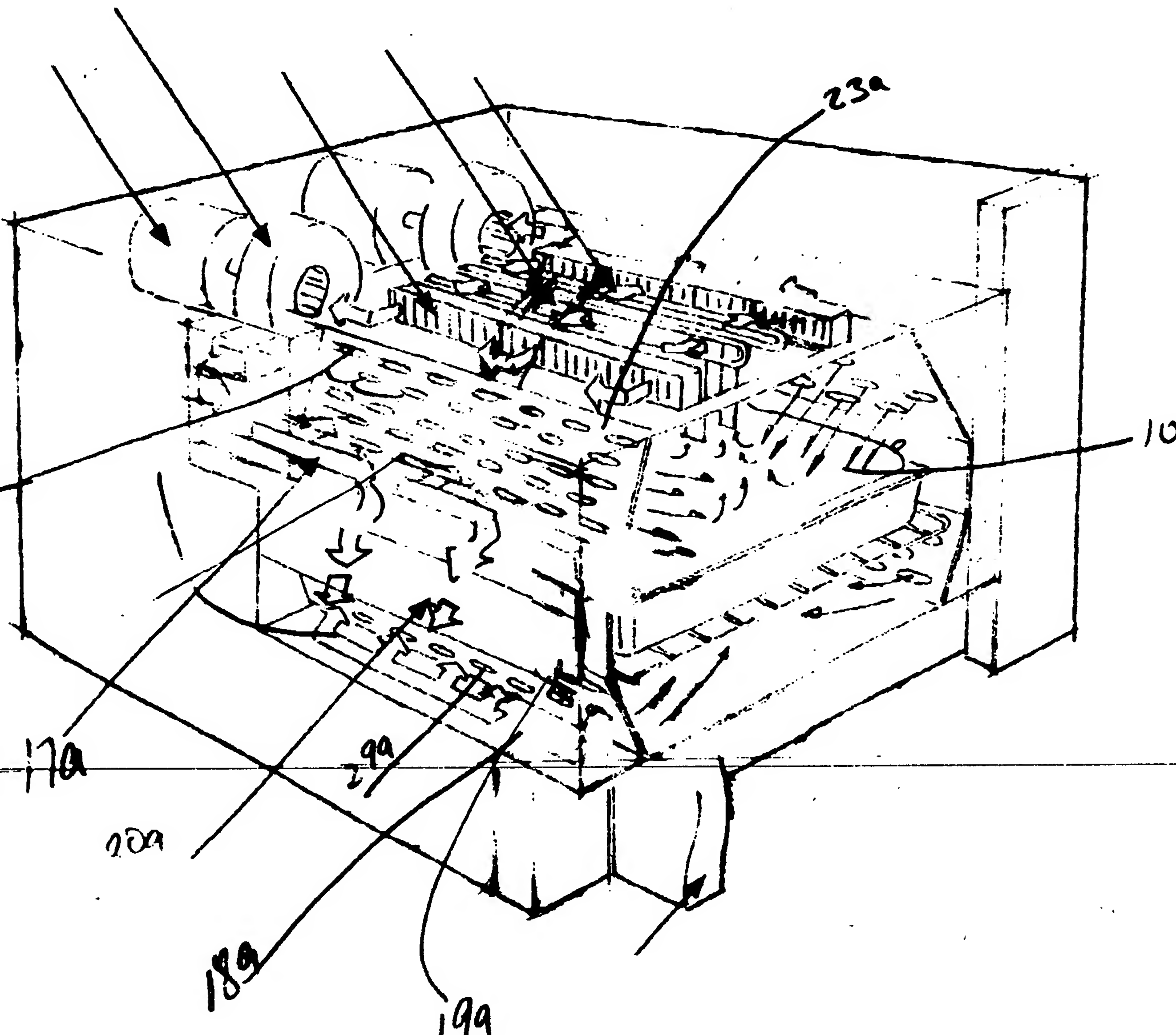
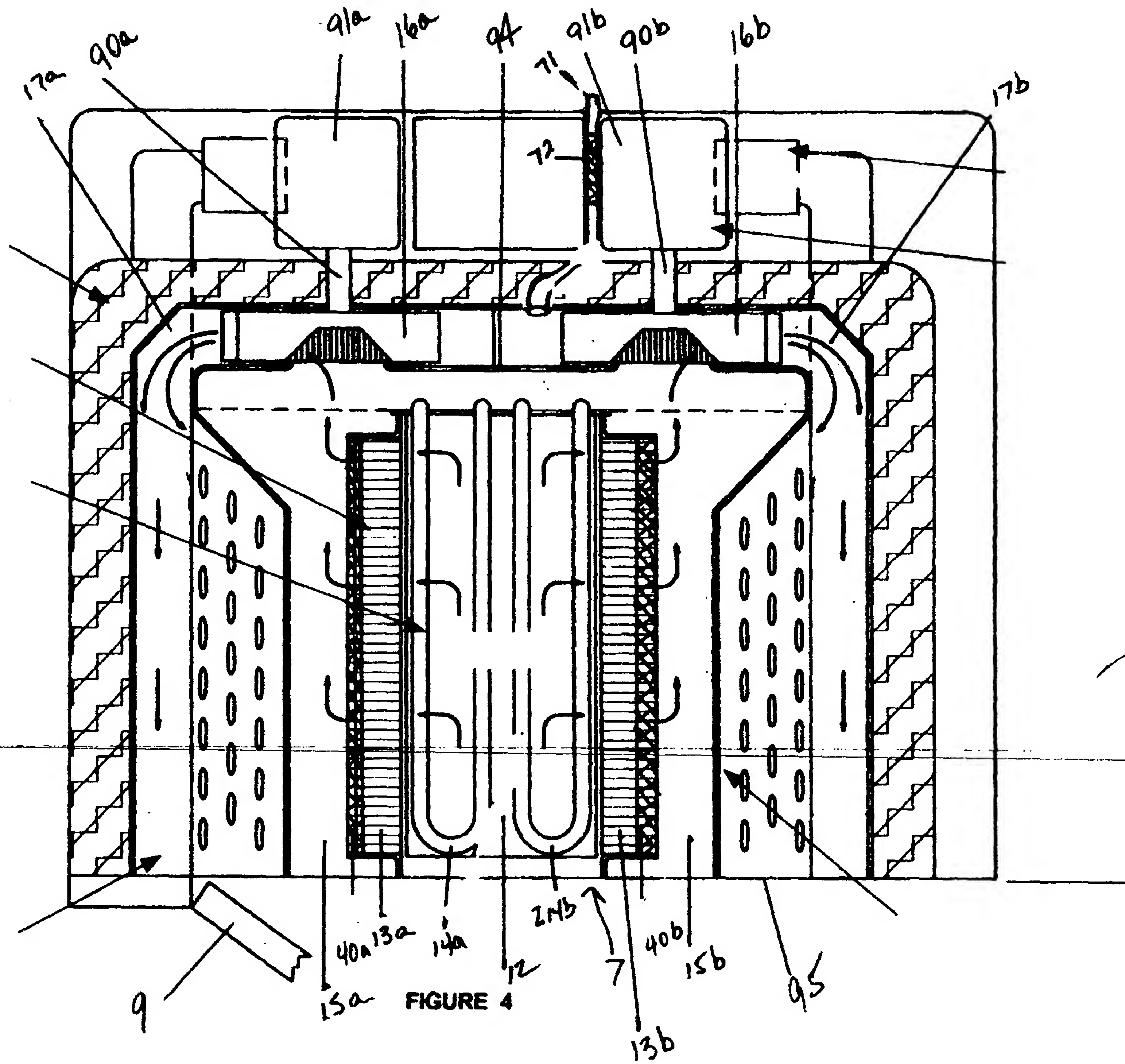
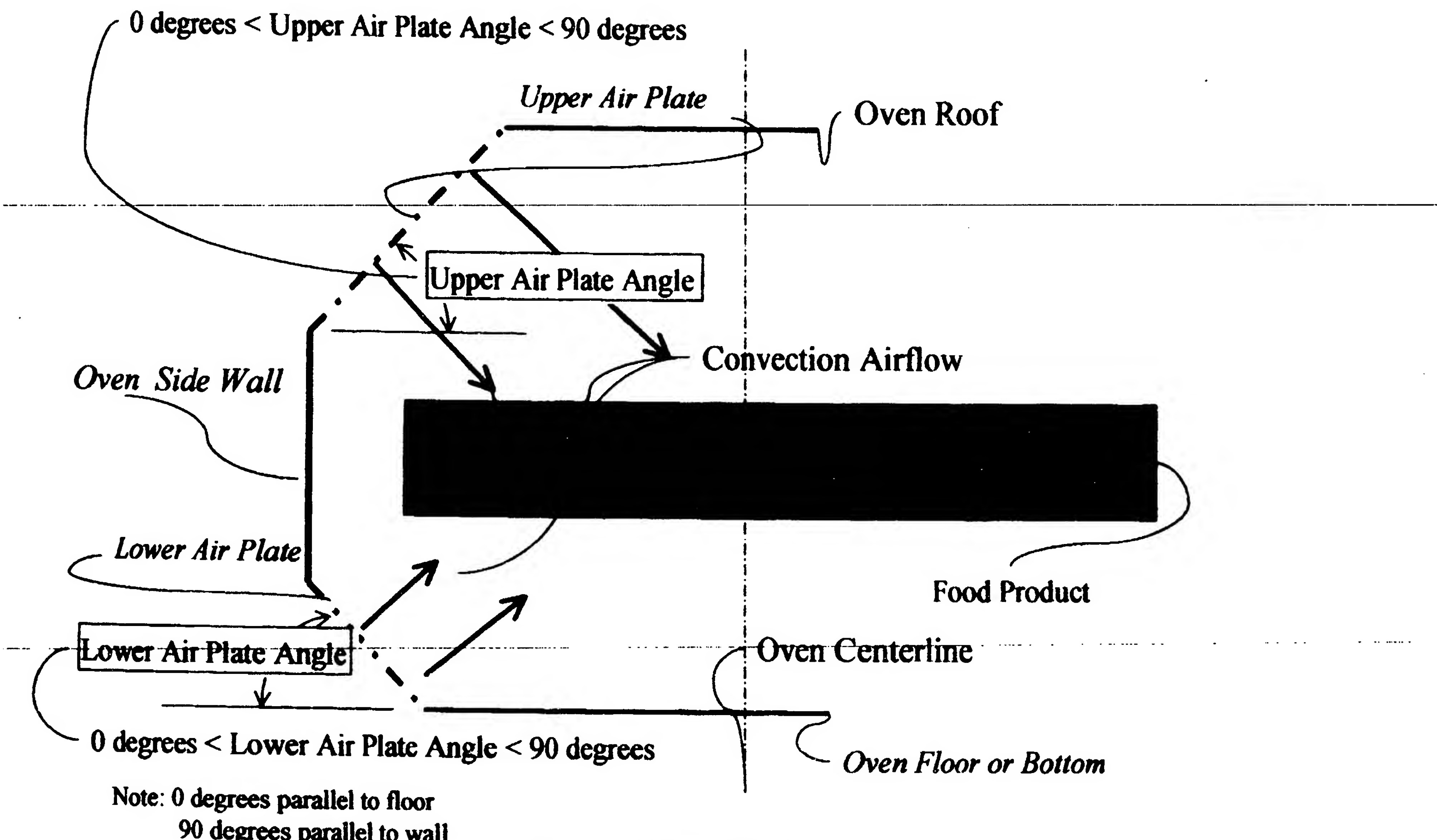


FIG 3



91a
16a
94
71
91b
90b
16b
17a
90a
17b
72
40a
13a
14a
12
2Nb
7
40b
15b
95
9
15a
13b

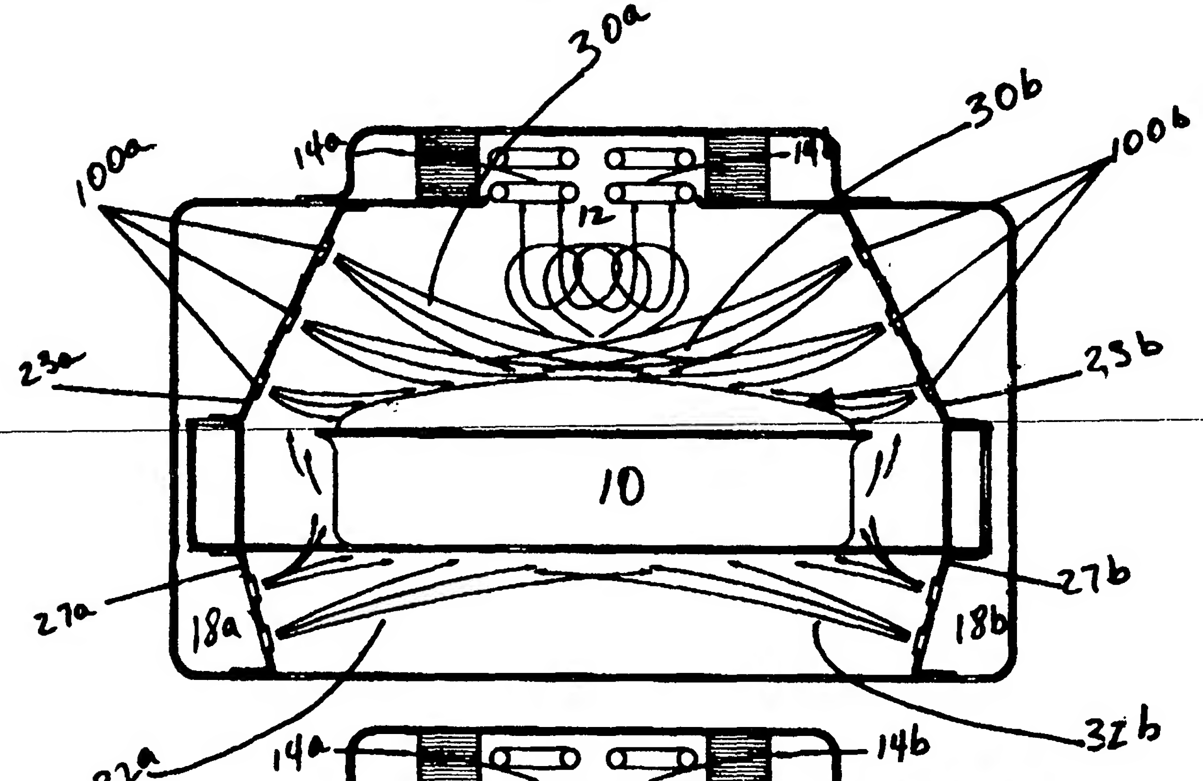
FIGURE 4



Front View of Oven Cavity

FIG 5

FIG. 6a



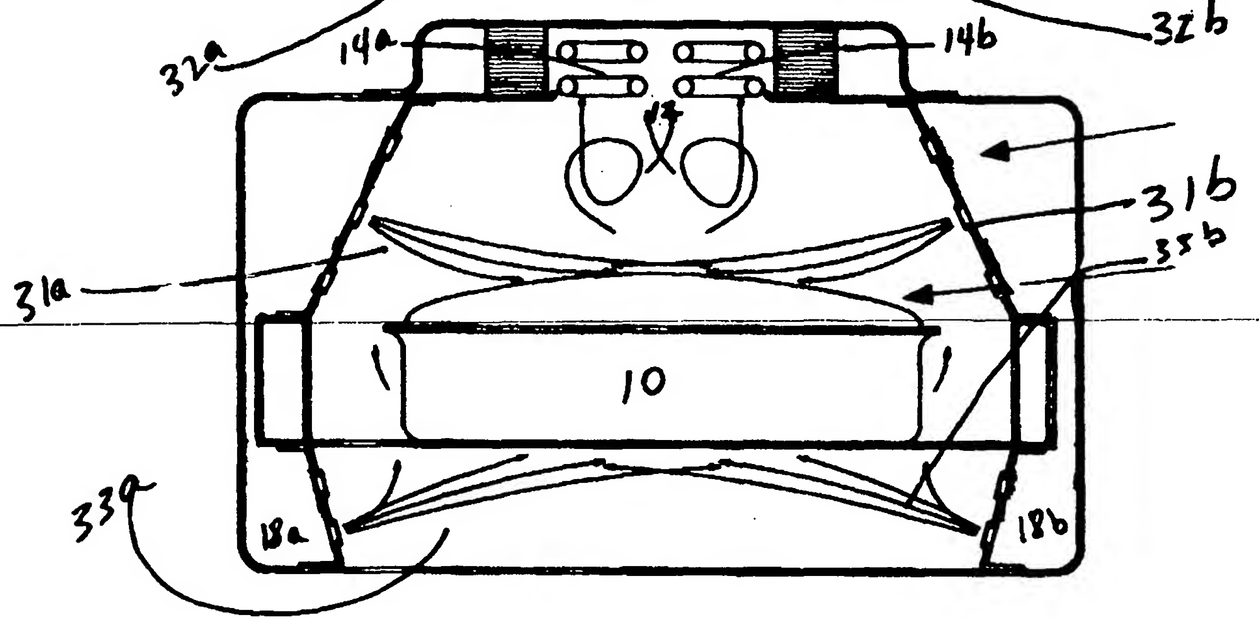


FIGURE 6b

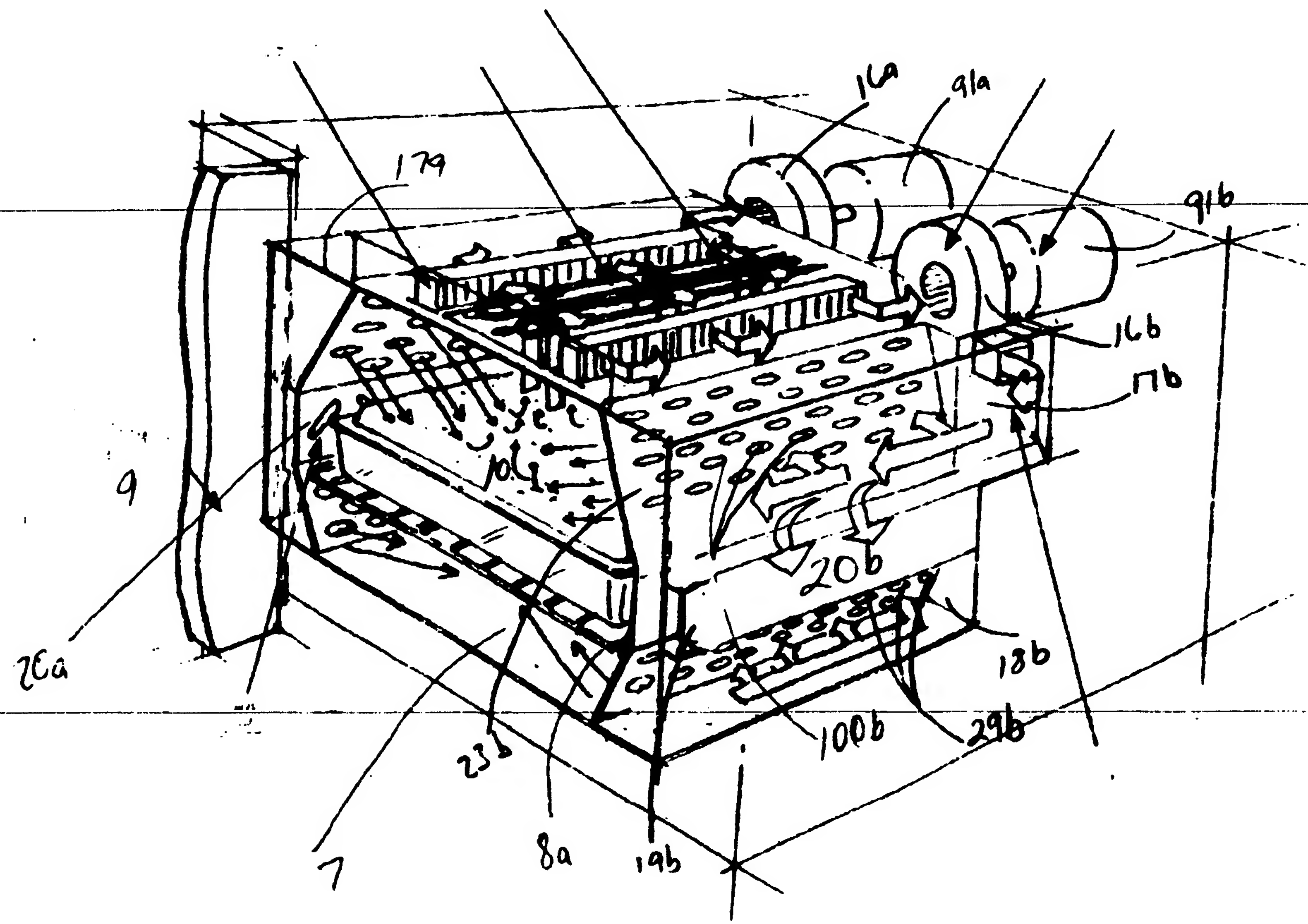


FIG 7

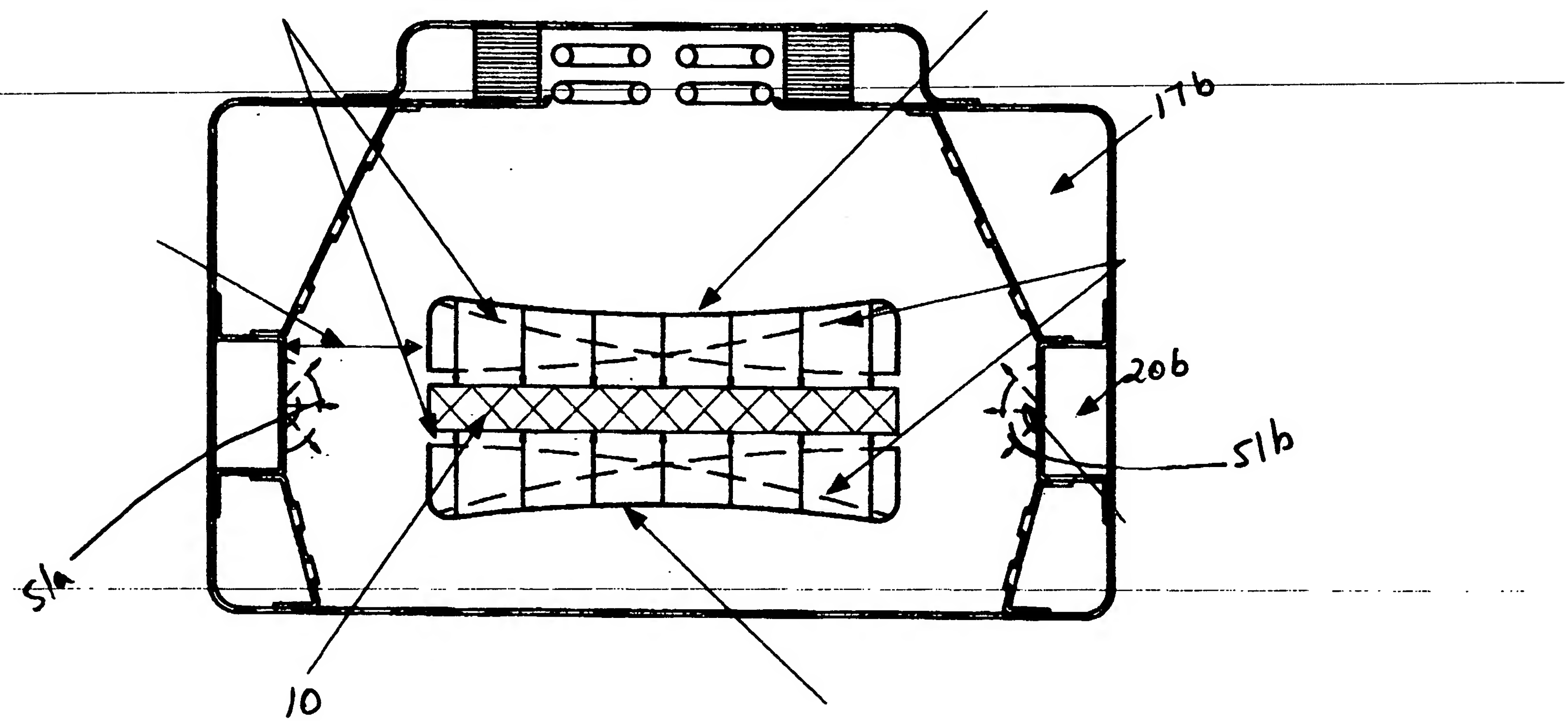


FIGURE 8

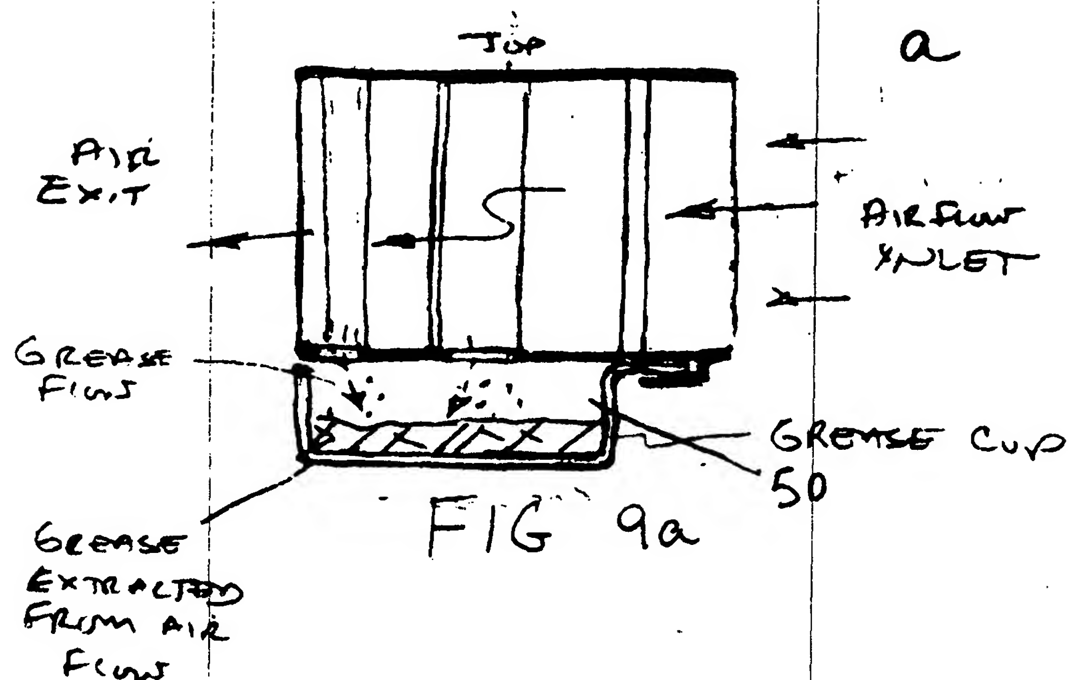


FIG 9a

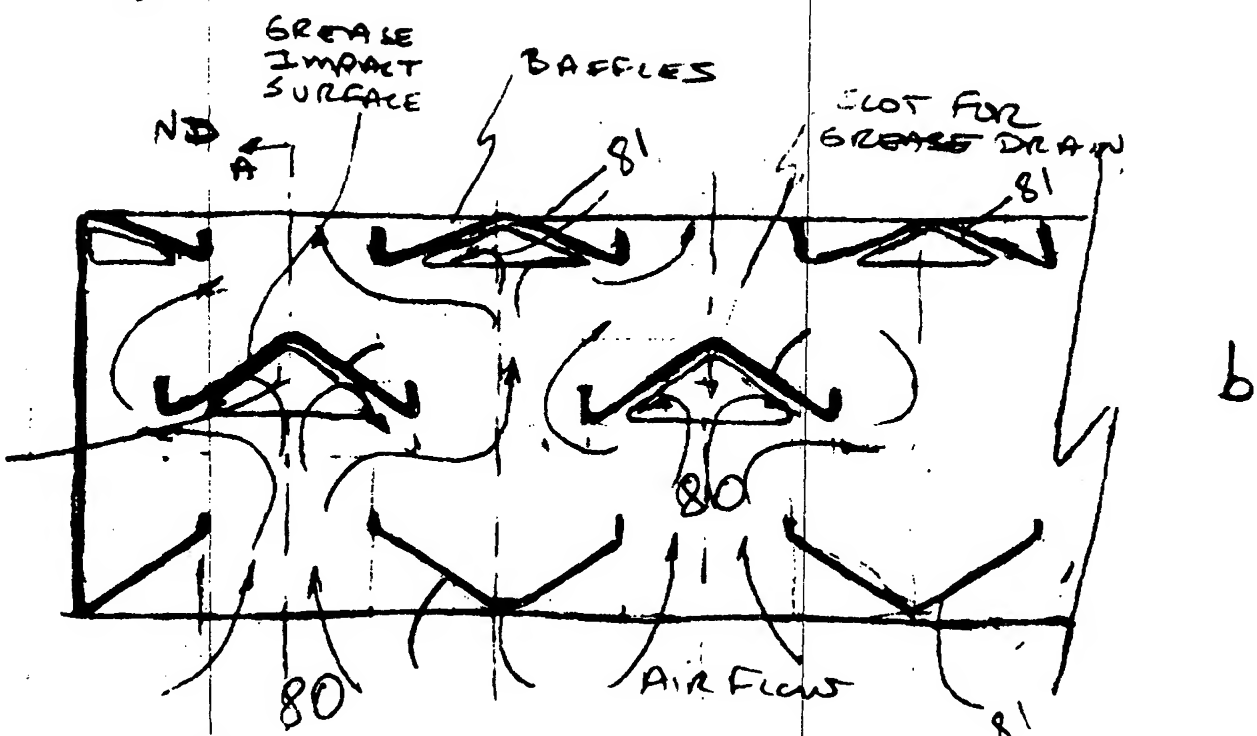


FIG_ _: GREASE BAFFLE

TOP VIEW / SECTION

FIG 9b

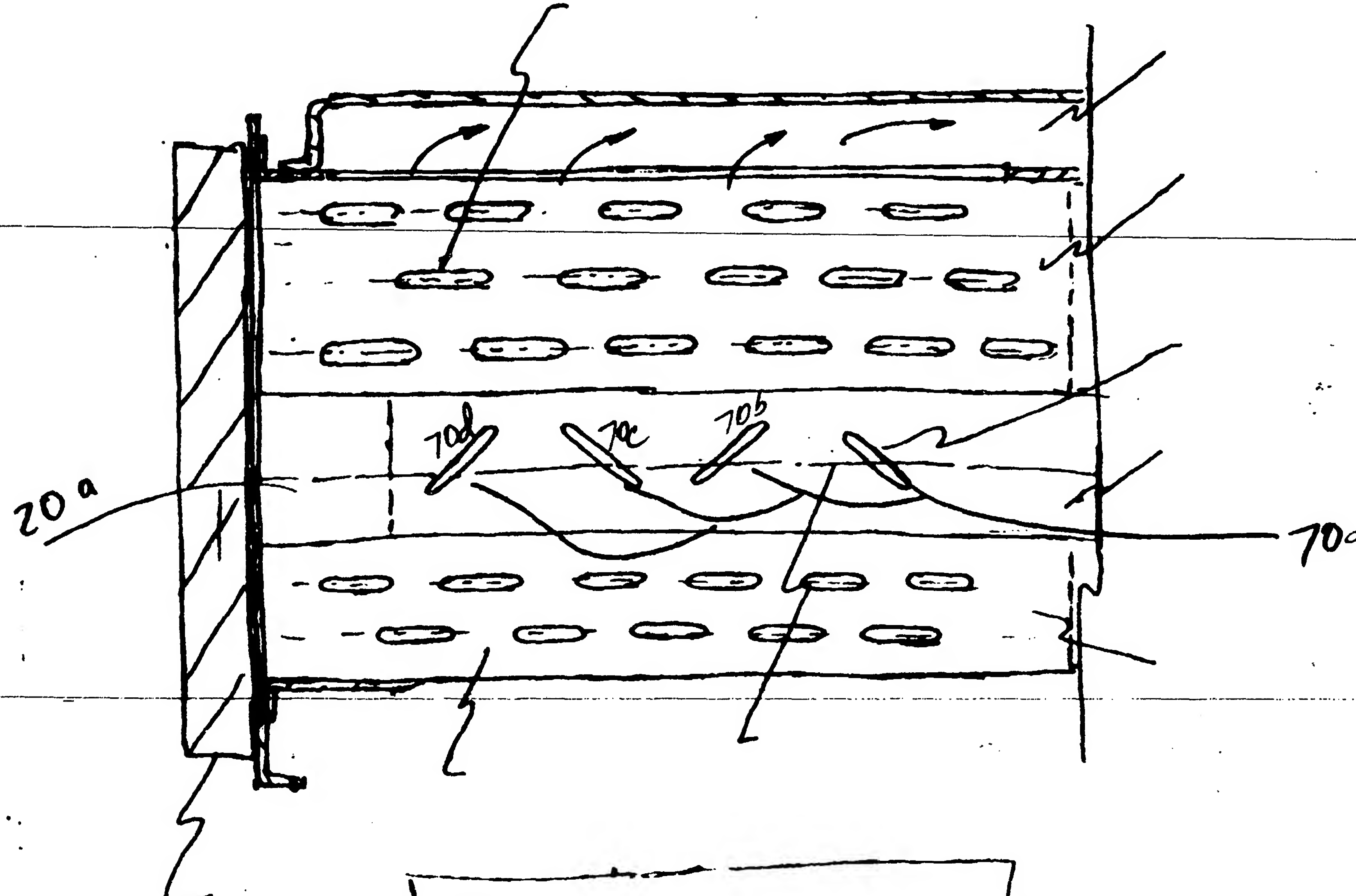


Fig 10